Indicator: Cardiovascular Disease Mortality (078)

The broad category of cardiovascular disease (CVD) includes any disease involving the heart and blood vessels. Coronary heart disease (CHD) and cerebrovascular disease, commonly known as stroke, are the major cardiovascular diseases (American Heart Association, 2003). Since 1900, cardiovascular disease has been the leading cause of death in the United States every year except 1918 (American Heart Association, 2003). The U.S. age-adjusted mortality rate for CVD reached a peak in 1950 (CDC, 1999). Between 1950 and 1999, the age-adjusted mortality rate for CVD declined 60 percent.

The major risk factors for CVD include tobacco use, high blood pressure, high blood cholesterol, diabetes, physical inactivity, and poor nutrition (CDC, 2004). Environmental factors (such as air pollution) may also contribute to overall CVD mortality. Environmental factors may play a role in CVD mortality independent of other risk factors, however, susceptible populations such as the elderly, smokers, and other high-risk populations may be most impacted. For example, chronic exposure to ambient airborne particulate matter has been shown in studies to be associated with increased hospitalizations and mortality among older individuals, largely due to cardiopulmonary and cardiovascular disease (EPA, 2004).

This indicator reflects the occurrence of cardiovascular disease deaths in the United States as recorded in the National Vital Statistics System (NVSS). Virtually all deaths are registered with the NVSS nationwide, and the cause of death is determined and recorded by a physician, medical examiner, or coroner. The temporal coverage of the data is from 1933 to present and data are collected from all 50 States and the District of Columbia.

What the Data Show

Figures 078-1, 078-2, and 078-3 present the overall trends in CVD, CHD and stroke mortality for the 10 EPA Regions and the Nation for the time periods 1979-1998 and 1999-2001. In 1998, the national age-adjusted CVD mortality rate was 352.0 per 100,000 compared to a rate of 541.0 per 100,000 in 1980 (Figure 078-1). This decline appears to continue after 1999 with the rate dropping from 349.3 per 100,000 in 1999 to 317.4 per 100,000 in 2002. Both CHD and stroke mortality rates have been declining in the United States. The age-adjusted CHD mortality rate ranged from 345.2 per 100,000 in 1980 to 197.1 per 100,000 in 1998. For stroke mortality the age-adjusted rate ranged from 97.6 per 100,000 in 1979 to 59.3 per 100,000 in 1998. The age-adjusted mortality rate (2000 U.S. Standard Population) for CHD and stroke in 2002 was 170.8 and 56.2 per 100,000, respectively, compared to 194.6 and 61.6 per 100,000, respectively, in 1999 (Figure 078-2, and Figure 078-3).

Like the national rates, the age adjusted CVD mortality rates (2000 U.S. Standard Population) have been decreasing over time in each of the 10 EPA Regions from 1979 to 1998. In 1979, rates in the 10 Regions ranged from 477.1 (Region 10) to 566.0 (Region 3) per 100,000 and in 1998 from 295.0 (Region 8) to 368.3 (Region 6) per 100,000. The decreasing trend in CVD mortality rates appears to continue during the period 1999-2001 (Figure 078-1).

Both CHD and stroke have been declining over time in the 10 EPA Regions. In 1979, CHD and stroke age-adjusted mortality rates (2000 U.S. Standard Population) ranged from 285.6 (Region 10) to 401.9 (Region 2) per 100,000 and 80.3 (Region 2) to 111.4 (Region 4) per 100,000, respectively. In 1998, CHD and stroke mortality rates ranged 145.6 (Region 8) to 233.2 (Region 2) per 100,000 and 43.2 (Region 2) to 68.5 per (Region 10) 100,000, respectively (Figures 078-2 and 078-3). The declining trends in CHD and stroke also appear to continue in the 1999-2001 period.

Differences exist in CVD mortality rates among gender, racial and age groups. In 2001, those aged 65 and older had the highest CVD, CHD and stroke mortality (2,188.9, 1,186.3, and 406.1 per 100,000,

respectively) compared to younger age groups (e.g., in 2001, the age-adjusted CVD, CHD, and stroke mortality rates for those 45-64 years of age were 187.2, 111.1, 24.1 per 100,000, respectively). Notable differences in CVD and CHD mortality rates exist between males and females, but not for stroke mortality. CHD mortality among men in 2001 was 228.5 per 100,000 compared to 139.9 per 100,000 for women. In 2001, black males had the highest CVD mortality rate at 505.3 per 100,000 compared to white males (381.1 per 100,000), black females (372.4 per 100,000) and white females (270.8 per 100,000).

Indicator Limitations

- CVD mortality rates are based on under-lying cause-of-death as entered on a death certificate by a physician. Some individuals may have had competing causes of death. "When more than one cause or condition is entered by the physician, the underlying cause is determined by the sequence of conditions on the certificate, provisions of the ICD, and associated selection rules and modifications" (CDC WONDER). Consequently, some misclassification of reported mortality might occur in individuals with competing causes of death.

- The difference in overall CHD and stroke mortality rate for 1999 quoted in ROE03 (195.6 per 100,000 and 61.4 per 100,000, respectively) versus the rate quoted in this updated reported (194.6 per 100,000 and 61.6 per 100,000, respectively) is that the rate in ROE03 was based on 1990 Census projections and the rate has since been adjusted for 2000 standard population.

- For the years 1979, 1981-1989, and 2001, if the user selects a CDC WONDER query for the United States with data grouped by state, or selects a WONDER query for a specific state, CDC WONDER reports state population figures that do not add up to the national population reported by CDC WONDER. This is because the two different sets of populations come from different U.S. Census population estimates. (For all other years, these two sets of population data are the same.)

- The International Classification of Diseases 9th Revision (ICD-9) codes were used to specify underlying cause of death for years 1979 - 1998. Beginning in 1999, cause of death is specified with the International Classification of Diseases 10th Revision (ICD-10) codes. The two revisions differ substantially, and to prevent confusion about the significance of any specific disease code, data queries are separate.

Data Sources

CDC. CDC WONDER. Compressed Mortality File, Underlying Cause of Death. http://wonder.cdc.gov. The complete web-link pathway from the CDC WONDER Home Page is:
→ Mortality—underlying cause of death → Mortality for 1999–2001 with ICD 10 codes.
Note: ICD-9 codes 390-434,436-448; ICD-10codes I00–I78 are listed as major cardiovascular diseases
Note: ICD-9 codes 410-414, 429.2; ICD-10 codes I20–I25 are listed as ischaemic heart diseases
Note: ICD-9 codes 430-434, 436-438; ICD-10 codes I60–I69 are listed as cerebrovascular diseases

The raw numbers for each state were downloaded from the CDC WONDER mortality database (http://wonder.cdc.gov). The raw numbers for each state within a region were combined and age adjusted rates (2000 U.S. Standard Population) were calculated.

NCHS. Deaths: Final Data for 2002. National Vital Statistics Reports. 53(5). October 12, 2004. Available at: http://www.cdc.gov/nchs/data/nvsr/nvsr53/nvsr53_05.pdf.

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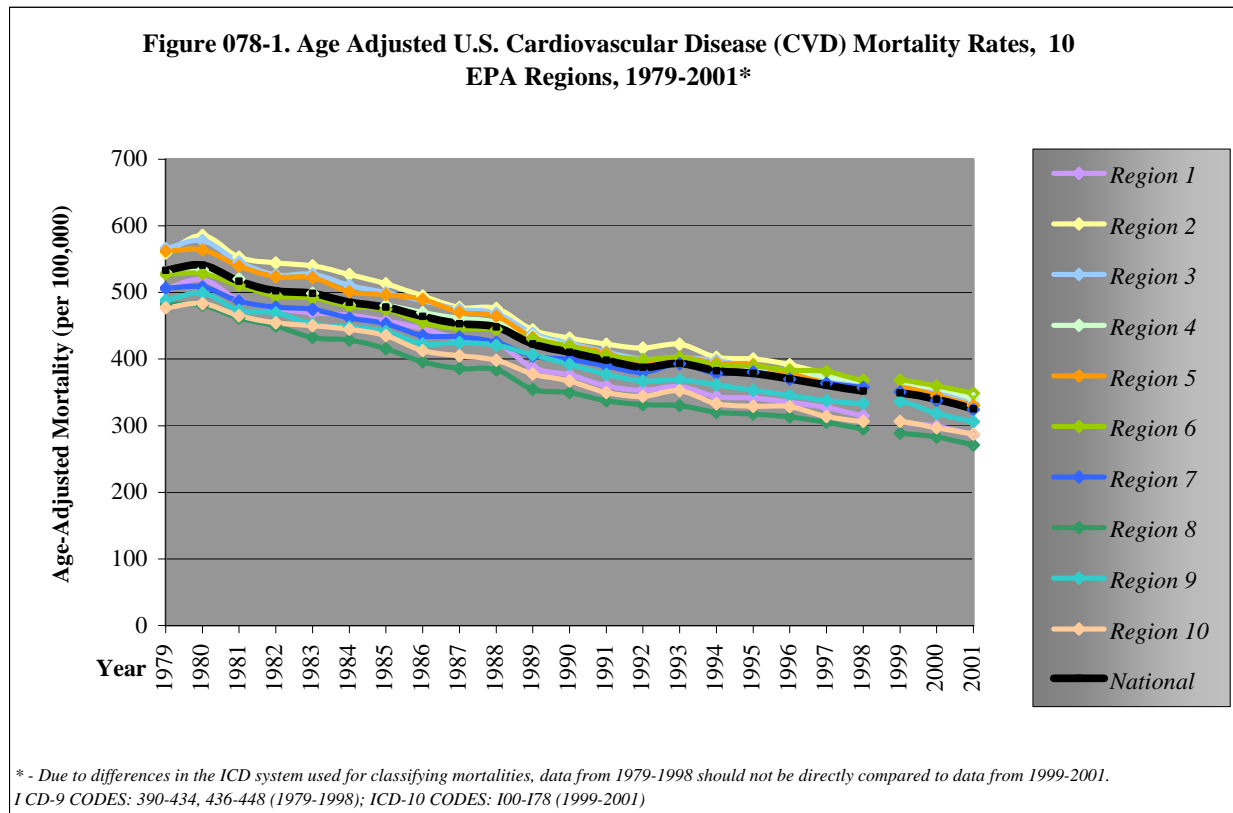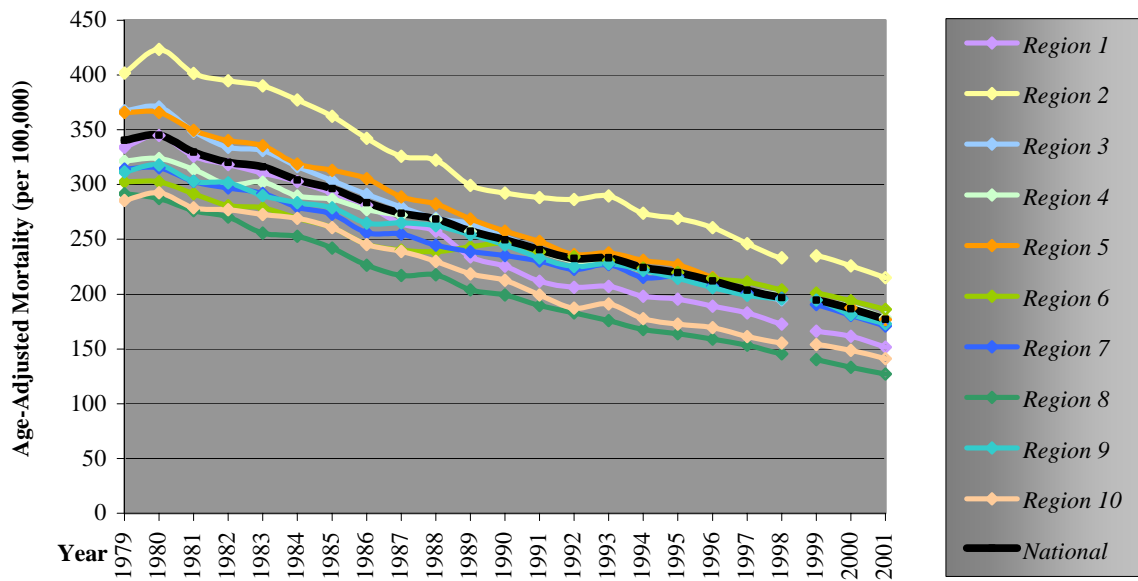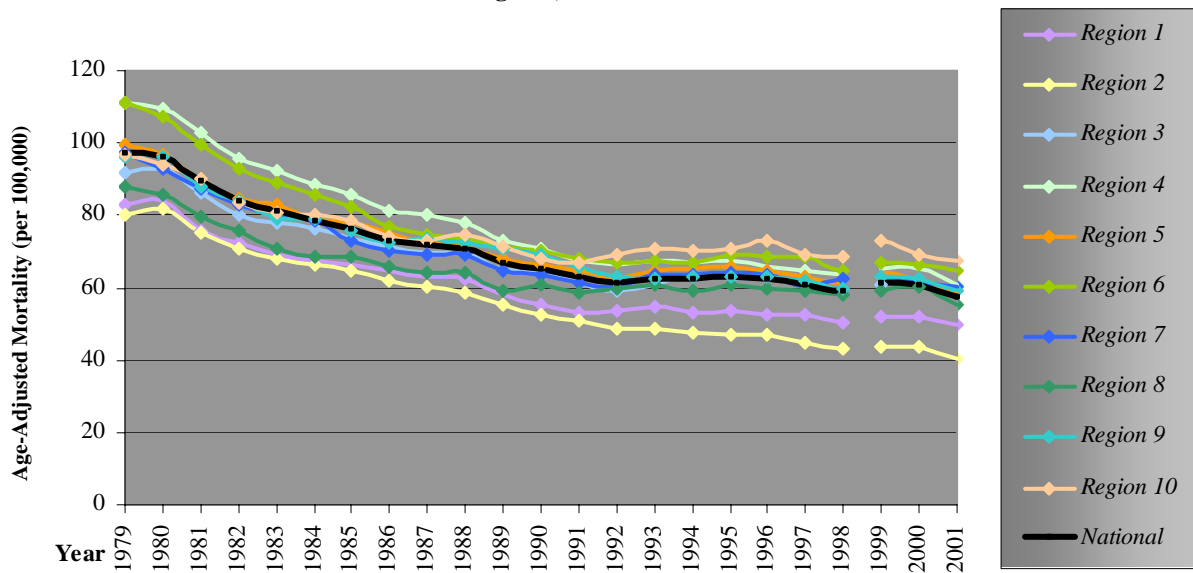
Graphics

Figure 078-1. Age Adjusted U.S. Cardiovascular Disease (CVD) Mortality Rates, 10 EPA Regions, 1979-2001*

* - Due to differences in the ICD system used for classifying mortalities, data from 1979-1998 should not be directly compared to data from 1999-2001.
I CD-9 CODES: 390-434, 436-448 (1979-1998); ICD-10 CODES: I00-I78 (1999-2001)

Figure 078-2. Age Adjusted U.S. Coronary Heart Disease (CHD) Mortality Rates, 10 EPA Regions, 1979-2001*

Y-axis: Age-Adjusted Mortality (per 100,000)

Legend: Region 1, Region 2, Region 3, Region 4, Region 5, Region 6, Region 7, Region 8, Region 9, Region 10, National

*- Due to differences in the ICD system used for classifying mortalities, data from 1979-1998 should not be directly compared to data from 1999-2001.
I CD-9 CODES: 410-414, 429.2 (1979-1998); ICD-10 CODES: I20-I25 (I999-2001)

Figure 078-3. Age Adjusted U.S. Stroke Mortality Rates, 10 EPA Regions, 1979-2001*

Y-axis: Age-Adjusted Mortality (per 100,000)

Legend: Region 1, Region 2, Region 3, Region 4, Region 5, Region 6, Region 7, Region 8, Region 9, Region 10, National

*- Due to differences in the ICD system used for classifying mortalities, data from 1979-1998 should not be directly compared to data from 1999-2001.
I CD-9 CODES: 430-434, 436-438 (1979-1998); ICD-10 CODES: I60-I69 (1999-2001)

R.O.E. Indicator QA/QC

Data Set Name: CVD MORTALITY
Indicator Number: 078 (89107)
Data Set Source: CDC, NCHS
Data Collection Date: ongoing
Data Collection Frequency: yearly
Data Set Description: CVD Mortality
Primary ROE Question: What are the trends in human disease and conditions for which environmental pollutants are thought to be to risk factors including across population subgroups and geographic regions?

Question/Response

T1Q1   Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

Yes. The National Vital Statistics System (NVSS) is the oldest and most successful example of inter-governmental data sharing in Public Health and the shared relationships, standards, and procedures form the mechanism by which NCHS collects and disseminates the Nation's official vital statistics. The methodology for collecting vital statistics is standardized and outlined in Model State Vital Statistics Act and Regulations Revised April 1995, DHHS publication (PHS) 95-1115 (http://www.cdc.gov/nchs/data/misc/mvsact92aacc.pdf)

T1Q2   Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

Yes. The National Vital Statistics System is responsible for the Nation s official vital statistics. These vital statistics are provided through State-operated registration systems. Standard forms for the collection of data and model procedures for the uniform registration of the events are developed and recommended for State use through cooperative activities of the States and the NCHS (http://www.cdc.gov/nchs/data/dvs/DEATH11-03final-ACC.pdf). U.S. Standard Death Certificates are revised periodically. Most state certificates conform closely in content and arrangement to the standard certificate recommended by NCHS and all certificates contain a minimum data set specified by NCHS. Demographic information on the death certificate is provided by the funeral director based on information supplied by an informant. A physician, medical examiner, or coroner provides medical certification of cause of death.

T1Q3   Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Yes. The data collected by NVSS are routinely referenced and used in epidemiological studies. Regional Mortality: Mortality rates age-adjusted for the 2000 U.S. standard population (rates per 100,000) for the years 1979 through 2001 were compiled through use of CDC WONDER. See attached file, age-adjusted regional rates.doc , for more information on the calculation of rates.

T2Q1   To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

Virtually all deaths are registered with the NVSS nationwide. The temporal coverage of the data is from 1933 to present. Data are collected from all 50 States including the District of Columbia.

T2Q2   To what extent does the sampling design represent sensitive populations or ecosystems?

The data set has nationwide death reporting, including sensitive populations.

T2Q3   Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

Not applicable

T3Q1   What documentation clearly and completely describes the underlying sampling and analytical procedures used?

The sampling and quality assurance information can be found in Model State Vital Statistics Act and Regulations Revised April 1995, DHHS publication (PHS) 95-1115 (http://www.cdc.gov/nchs/data/misc/mvsact92aacc.pdf). Documentation is also available at http://wonder.cdc.gov/wonder/help/mort.html Data source for Table HH2: CDC. CDC WONDER. Compressed Mortality File, Underlying Cause of Death. http://wonder.cdc.gov. The complete web-link pathway from the CDC WONDER Home Page is: à Mortality underlying cause of death à Mortality for 1999 2001 with ICD 10 codes For 2002 data: National Center for Health Statistics (NCHS). 2004. Deaths Final Data 2002. National Vital Statistics vol 53 no. 5 http://www.cdc.gov/nchs/data/nvsr/nvsr53/nvsr53_05.pdf Regional Mortality: Mortality rates age-adjusted for the 2000 U.S. standard population (rates per 100,000) for the years 1979 through 2001 were compiled through use of CDC WONDER. See attached file, age-adjusted regional rates.doc , for more information on the calculation of rates.

T3Q2   Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

The data can be accessed up to the county level through the electronic data warehouse for CDC at http://wonder.cdc.gov. Individual level data are not available due to confidentiality issues.

T3Q3   Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Yes. Virtually all deaths from the 50 states, including District of Columbia, submit mortality data to the NVSS at NCHS. The recommended certificate of death is posted at http://www.cdc.gov/nchs/data/dvs/DEATH11-03final-ACC.pdf. The documentation for the mortality data set is http://wonder.cdc.gov/wonder/help/mort.html.

T3Q4   To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

See answer to T3Q1

T4Q1   Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

Not applicable

T4Q2   Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Not applicable

T4Q3   Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

Not applicable

T4Q4   Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

The mortality data on the Compressed Mortality File at http://wonder.cdc.gov/mortSQL.html are based on records for all deaths occurring in the fifty states and the District of Columbia. Deaths to foreign residents are excluded. Deaths to residents who died abroad are not included on this file. The difference in overall CHD and stroke mortality rate for 1999 quoted in ROE03 (195.6 per 100,000 and 61.4 per 100,000, respectively) versus the rate quoted in this updated reported (194.6 per 100,000 and 61.6 per 100,000, respectively) is that the rate in ROE03 was based on 1990 Census projections and the rate has since been adjusted for 2000 standard population. Cardiovascular mortality rates are based on under-lying cause-of-death as entered on a death certificate by a physician. Some individuals may have had competing causes of death. When more than one cause or condition is entered by the physician, the underlying cause is determined by the sequence of conditions on the certificate, provisions of the ICD, and associated selection rules and modifications. (CDC WONDER database) The 2002 mortality rates were not yet available in CDC WONDER database at the time of this indicator write-up. The age-adjusted mortality rates were obtained through National Center for Health Statistics publication. For purposes of comparison, it should be noted that mortality rates reported by NCHS reports differ slightly from those rates reported by CDC WONDER. NCHS uses U.S. Census Bureau population estimates for all age groups; CDC WONDER uses birth certificate data for the Under 1 Year age group and uses U.S. Census Bureau population estimates for all other age groups. The International Classification of Diseases 9th Revision (ICD 9) codes are used to specify underlying cause of death for years 1979 - 1998. Beginning in 1999, cause of death is specified with the International Classification of Diseases 10th Revision (ICD 10) codes. The two revisions differ substantially, and to prevent confusion about the significance of any specific disease code, data queries are separate. Regional data: Mortality data are not available for the U.S. territories in CDC WONDER. Thus, Regions 2 and 9 are calculated to include only States. Note that for the years 1979, 1981-1989, and 2001, if the user selects a WONDER query for the United States with data grouped by state, or selects a WONDER query for a specific state, WONDER reports state population figures that do not add up to the national population reported by WONDER. This is because the two different sets of populations come from different U.S. Census population estimates. (For all other years, these two sets of population data are the same.)

Calculation of Age-Adjusted Regional Mortality Rates Using State Data from CDC WONDER

Mortality rates age-adjusted for the 2000 U.S. standard population (rates per 100,000) for the years 1979 through 2001 were compiled as detailed below. (Mortality data for 2002 and later are not yet available through CDC WONDER.)

Identifying relevant data

- Each mortality indicator (e.g., cancer, cardiovascular disease, asthma) was reviewed based on EPA's 2003 Draft Report on the Environment and a National Center for Health Statistics (NCHS) report that discusses ICD (International Classification of Diseases) to obtain the ICD codes that describe each of these indicators. Due to a revision of the ICD system in 1999, ICD-9 codes were obtained for the years 1979-1998 and ICD-10 codes for the years 1999-2001.

Downloading and organizing the data

- Mortality data were accessed through CDC's WONDER database (http://wonder.cdc.gov/).

- We downloaded a file for each year that regional mortality indicators were requested (1979-2001) and saved these data into separate sheets in Microsoft Excel (one workbook for each indicator). Both raw and compiled data are presented in each of these Excel workbooks. For example, '1999D' is the sheet with the raw data for the year 1999 and '1999' is the sheet with the calculations for that year.

- The calculation worksheet is organized as follows:

    o The first table arranges the raw data by state and age group. For each age group and state, two numbers are presented: the mortality cases and the associated population.

    o The second table (Regional Breakdown) groups the mortality cases and populations for the 50 states plus Washington, D.C., into the ten EPA regions, to obtain the total cases and total population for each region, by age group. (For a map of the EPA regions, refer to http://www.epa.gov/epahome/whereyou-live.htm.)

    o The third table (Regional Breakdown [combine certain groups]) merges two sets of age groups with each other (5-9 years with 10-14 years; 15-19 years with 20-24 years) to match the age-adjustment methodology used to calculate age-adjusted mortality rates in CDC WONDER (see below).

    o The fourth table on the worksheet (Regional Breakdown [Computation of Age-Adjusted Rate Components]) presents the basic steps of calculating age-adjusted mortality rates for each region (see below).

    o The final table on the Excel sheet (Regional Summary) lists the age-adjusted rates for each region and for the entire US; these values are compiled into the summary sheet that covers all regions for all years for an indicator, accompanied by a trend chart that graphically depicts the regional data.

Calculating age-adjusted regional rates

The steps followed in calculating age-adjusted regional rates are detailed below, followed by a sample calculation.

Step 1

Using the following equation, the *crude death (or mortality) rate* is obtained by dividing the mortality cases (*Cases$_i$*) by the population for that age group (*Population$_i$*), then by multiplying by 100,000 (to get the cases per 100,000). This is done for each age group within each region. (The "i" subscript is included to indicate that this calculation is performed for several age groups, i.e. *CrudeRate$_{<1\ year}$*, *CrudeRate$_{1-4\ years}$*, etc.)

$$CrudeRate_i = \frac{Cases_i}{Population_i} \times 100{,}000$$

Step 2

For each age group, the weighted age-adjusted factor is calculated, using 2000 U.S. standard population factors provided by NCHS (See Table 1 below). The age-specific crude death rate is multiplied by that age group's standard population for the year 2000 (*2000 Population$_i$*), and then divided by the total standard population for the year 2000 (*2000 Population$_{total}$*). (For details on the standard population, see "Age-Adjustment of Death Rates" on the web page http://wonder.cdc.gov/wonder/help/mort.html[1]).

$$WeightedFactor = CrudeRate \times \frac{2000\,Population_i}{2000\,Population_{total}}$$

Table 1. United States Standard Population*

Age	Number
Under I year	13,818
1-4 years	55,317
5-14 years	145,565
15-24 years	138,646
25-34 years	135,573
35-44 years	162,613
45-54 years	134,834
55-64 years	87,247
65-74 years	66,037
75-84 years	44,842
85 years and over	15,508
All ages	1,000,000

 * Based on year 2000 projected population

Step 3

The age-adjusted mortality rate is then obtained by adding together the individual weighted factors for each age group:

$$AgeAdjustedRate = \sum_i WeightedFactor_i$$

Sample Calculation

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[1] The source cited by CDC WONDER for the age-adjustment data is the following NCHS report: *Anderson RN, Rosenberg HM. Age standardization of death rates: Implementation of the year 2000 standard. National Vital Statistics Reports; Vol 47 No 3. Hyattsville, Maryland. National Center for Health Statistics. 1998.*

Table 2 (below) shows the output of a sample calculation of the age-adjusted mortality rate for cancer (across all age groups) in EPA Region 9 in 1982. (Note that we have presented this in a format that is not used in the Excel workbook, in order to illustrate the calculations for a single region. However, all of the steps and calculations are identical.)

For each age group, the number of mortality cases is the sum of the mortality cases for Arizona, California, Hawaii, and Nevada, for that age group in that year; the population is the sum of the populations of these same four states for that age group in that year. For example, for the 35-44 years age group, the number of cancer mortalities for these states are 112 (Arizona), 1,413 (California), 53 (Hawaii), and 55 (Nevada), with the sum equaling 1,633. Similarly, the population is the sum of the respective states 338,654 (Arizona), 3,152,885 (California), 124,743 (Hawaii), and 120,463 (Nevada), which equals 3,736,745. The crude rate (43.70) for this age group is therefore equal to the total number of mortality cases (1,633) divided by the total population (3,736,745), multiplied by 100,000.

Table 2. Cancer Mortality, All Age Groups, EPA Region 9, 1982.

Age Group (Years)	Mortality Cases	Year 1982 Population	Crude Death Rate	2000 Std. Population	Weighted Factor
<1 year	32	515,809	6.20	13,818	0.09
1- 4 years	108	1,824,635	5.92	55,317	0.33
5- 9 years	114	1,977,487	N/A		
10-14 years	94	2,188,828	N/A		
5-14 years	208	4,166,315	4.99	145,565	0.73
15-19 years	139	2,432,939	N/A		
20-24 years	180	2,884,175	N/A		
15-24 years	319	5,317,114	6.00	138,646	0.83
25-34 years	694	5,551,792	12.50	135,573	1.69
35-44 years	1,633	3,736,745	43.70	162,613	7.11
45-54 years	4,662	2,793,603	166.88	134,834	22.50
55-64 years	11,283	2,679,802	421.04	87,247	36.73
65-74 years	15,423	1,876,606	821.86	66,037	54.27
75-84 years	11,397	912,865	1248.49	44,842	55.98
85+ years	4,424	269,593	1640.99	15,508	25.45
Unknown	27	0	N/A	0	0
Total	50,210	29,644,879	N/A	1,000,000	N/A
Age-Adjusted Mortality Rate					205.7

As described above, the Weighted Factor is the Crude Death Rate multiplied by the 2000 Standard Population for that age group and divided by the total Standard Population (the total of the age-group populations). For example, the weighted factor for the 35-44 years age group is the crude rate (43.70) times the 2000 population for that group (162,613), divided by the total 2000 Standard Population (1,000,000), which equals 7.11. The 1982 Region 9 age-adjusted mortality rate, 205.7, is the sum of the weighted factors of all age groups.

Notes:

- For the 5-14 and 15-24 years categories it is necessary to merge two sets of age ranges to match the age-adjustment grouping used within WONDER.

- For mortality indicators that were also compiled for children (ages 0-19 years), we only used the data for the age groups 0-1, 1-4, 5-9, 10-14, and 15-19 years, and then we age-adjusted these data using a set of age-adjustment factors that only cover to age 19 years.

- For the file that compiles birth defect mortality rates, the only data used from CDC WONDER are for the <1 year age group, so the crude rate equals the age-adjusted rate.

- Although data were queried for individual states to compile regional data, we did this by querying data for the entire United States from the CDC WONDER system, and specifying that the data be grouped by age and by year. Due to a quirk of CDC WONDER, if the user selects a single state for a query (instead of the entire United States), the population data are taken from a different data source: there are small discrepancies between these numbers and so the state-specific query should not be used to verify these compiled data.